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## ON THE ESSENCE OF CYBER SPACE AND ITS RELATIONSHIP WITH CYBERNETIC SPACE

*The subject of the study is understanding of the relationship between the concepts of cyberspace and cybernetic space. The goal is to clarify the essence of the concept of cyberspace and outline its relationship with the cybernetic space. The task is to distinguish between these two concepts. These concepts are not identical in essence, which is often not paid attention to, therefore, based on the clarification of the concept of cyberspace, it is appropriate to show the relationship between them. Used methods: systematic and logical approaches, methods of comparison and analysis. The following results were obtained. During the analysis of well-known publications, a number of mutual disagreements in the interpretation of the cyberspace concept, as well as facts of unjustified identification of the terms «cyberspace» and «cybernetic space» were revealed. This harms the application of unified approaches to the consideration of digital information systems and management systems in general, which needs to be corrected. Based on William Gibson, a new generalized definition of the cyberspace concept is proposed. This concept is supported by the Okinawa Charter of the Global Information Society in 2000. It also takes into account the common features that characterize the full range of features associated with the formation, storage and use of electronic information resources. Based on this, as well as the essence of the «cyberspace» concept according to Norbert Wiener, the difference and relationship between cyberspace and cyberspace is shown. The concepts of «local cyberspace», «global cyberspace», «virtual cyberspace» are defined and the need to distinguish between them is indicated. The obtained results emphasize the need to distance the classical cybernetic theory from modern theories related to the concept of cyberspace. This also draws attention to the need for the correct application of the modern theories terminological base as a basis for understanding their provisions, in the interests of the development and proper functioning of digital information systems and management systems.*

**Keywords** cyberspace, cybernetic space, interconnection.

### Introduction

Today in the modern world there is a rapid development of information technology, total computerization and implementation of telecommunications networks, especially the Internet. For this reason, the advanced countries of the world, through the information sphere, based on the synthesis of available information resources, have a fundamentally new opportunity to achieve their national interests. Such resources should be understood as cognitive (related to human consciousness and knowledge), non-electronic (related to symbolic systems and alphabets), and electronic (related to the digital format of processing and storage of data and information). The variety and speed of practical implementation of such a synthesis has led to a lag in the theoretical generalizations of information and related processes, which have already acquired a global character.

The consequence of this lag is, first of all, terminological uncertainty and confusion. As a result, the opportunity to understand, consider, research and implement processes in the information sphere from a single systemic position is lost. In particular, the concept of cyberspace, with which the essence of all automated (digital) information systems is connected, is increasingly acquiring the level of fundamentality. Note that today the concept of cyberspace is normatively standardized, but with a dubious emphasis on the Internet environment.

Therefore, the concept of cyberspace remains debatable regarding its definition and adequate understanding. Moreover, the term «cyberspace» is often perceived as «cyber space», considering these terms as analogues, which is questionable from the standpoint of cybernetics - the science of the most general laws of management in wildlife, technology and social environment. Thus, both the debate over the concept of cyberspace and its relationship to the essence of cyberspace call for a further, deeper, but more generalized, explanation of these issues.

**Problem statement.** As evidenced by numerous modern publications, a large number of terms and their meanings are associated with the prefix «cyber». This prefix was first introduced into modern scientific terminology in the 1940s by Norbert Wiener, and later used by other scientists, in the sense of «cybernetics» as a definition of the general essence of management in wildlife, technology and society.

In a relatively narrow scientific environment, the concept of cybernetics was perceived unambiguously and was always clear. It is also clear that the basis of any cybernetic process (management process) is information and related information processes and information systems. In such a paradigm, theoretical thought and practical activities were developed for a long time.

Meanwhile, the prefix «cyber» has been widely used since the late 80's of the twentieth century, but not from the standpoint of development and

popularization of the N. Wiener's cybernetic theory, and «lightly» Canadian science fiction writer William Gibson (as noted by literary critics, the founder of the literary genre cyberpunk). In one of his fantasy novels (1984 year), he used the term «cyberspace» to refer to the digital world of computer networks (in the author's sense, neural networks). Gibson's «cyberspace» was picked up by a wide readership in the context of active development and use of the Internet and became the progenitor of all subsequent synthetic terms with the prefix «cyber» (including the symbolic terms «cybersecurity», «cyberattack», «cyberdefense», «cybercrime»). Such concepts are used today in various spheres of life - from everyday life to law-making processes.

**Analysis of recent research and publications (literature review).** For the first time at the official level, the term «cyberspace» was used at the turn of the XX and XXI centuries during the Paris Conference of the Group of Eight on «Dialogue between government and industry on security and trust in cyberspace» and the «Okinawa Charter of the Global Information Society» [1]. At that time, cyberspace was seen as an information environment created by computer networks, in which you can make a certain set of legal relationships. This concept of cyberspace clearly demonstrates the direct influence of Gibson's «cyberspace», as it corresponds almost literally to it.

Since then, there has been a discussion in the professional community about the clearest definition of this important term in theory and practice, as well as derivative terms such as «cybersecurity», «cyberdefense», «cyberattack» and so on. In particular, many publications by both foreign and Ukrainian authors are devoted to this issue, among which we note the works of D. Lipman [2], D. Lewis [3], D. Dubov [4, 5], V. Buryachok [6, 7], V. Lipkan [8, 9], O. Baranov [10]. In their works, much attention is paid to the concept of cyberspace, based on the author's understanding. Today, this concept already has many definitions, which are editorially different in some way. For example, in the textbook of the Ukrainian authors V. Buryachok, V. Tolubko, V. Khoroshko, S. Tolyupa [7] provided for more than ten concepts of the essence of cyberspace.

Meanwhile, despite the author's numerous attempts at the most successful detailing of the concept of cyberspace, the known variants tend to gravitate towards Gibson's concept of «cyberspace», since the authors' definition is based on the presence of a computer network and the possibility of information interaction in such a network.

At the same time, taking into account the dominant trend of the development of various services and information systems based on the Internet, the international standard ISO/IEC 27032: 2016 [11], which is close to this issue, is also recognized as the state standard of Ukraine. This standard defines that cyberspace is a complex environment of interaction between people, software and services on the Internet and functions with the support of integrated networks

and devices in information and communication technologies. Another international standard ISO/IEC 27100:2020 [12] categorically emphasizes that such an environment must be publicly available as the Internet and cannot be an internal publicly unavailable (closed) network of the organization. In our opinion, limiting the cyber environment of interaction to the Internet is a significant shortcoming of this standardized definition. This approach rejects similar digitized environments, both global and local information systems (where people, software and services also interact) from the processes of theoretical generalization and the application of unified approaches to their consideration both in theory and in practice.

The influence of well-known publications, the context of the «Okinawa Charter» and international standards is felt in the definition given in the national legislation of Ukraine [13]:

*cyberspace* – an environment (virtual space) that provides opportunities for communication and / or social relations, formed as a result of the operation of compatible (connected) communication systems and the provision of electronic communications using the Internet and / or other global data networks.

This and other similar definitions are faced with several fundamental questions:

Why virtual (artificially created) space?

Why electronic communications only using the Internet and / or other global data networks?

Where in the educational environment do electronic information resources (EIR) for electronic communications come from?

Why is there only communication in cyberspace, which is only mutual communication (communication)?

The very possibility of asking such questions testifies to the limited, local nature of this and other related definitions of the concept of cyberspace. In addition, the above and other definitions in the context do not set out any signs of the relationship between cyberspace and cybernetic space.

For this reason, an uncertain understanding of the essence of the term «cyberspace» leads to its free and inappropriate use with cases of further interpretation or modification without any particular need for it. As an example, in the generally interesting scientific and practical position of the publication on increasing the level of protection in wireless mobile data transmission channels [14], such author terminological constructions as «cyber-physical space» and «cyber-physical systems» are used. They attract attention due to terminological incomprehensibility, but in no way affect the essence of the presented scientific result.

In addition to the above, the given legislative and other definitions contextually do not show any signs of the relationship between cyberspace and cybernetic space. Also, due attention has not yet been paid to this issue in professional publications, which requires separate coverage.

**The purpose of the article** is to clarify the concept of cyberspace and to outline the relationship between cyberspace and cybernetic space.

### Principal Research Results

Achieving this goal primarily requires clarification of the concept of cyberspace, for which it is necessary to define a certain concept for solving this problem. The basis of this concept is the idea of the writer W. Gibson. The idea does not contradict the official context of cyberspace in the Okinawan Charter [1] and most well-known professional publications. They claim that *cyberspace is an information environment created by computer networks, which provides interaction (communication) in digital form (codegrams)*. It should be noted that a computer network with a topology of any configuration and complexity is created and maintained as an element of a certain information infrastructure. Based on this, it is obvious that the simplest topology of the cyberspace computer network can be formed by a couple of computers that can technically interact with each other, as shown in Figure 1 (the simplest because it still provides creating a virtual structure by the connection of software logic of two computers into one).

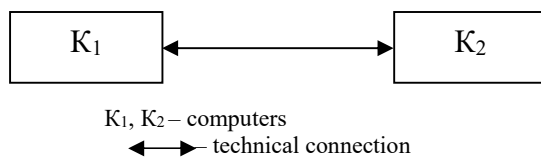


Figure 1 – The simplest topology of a computer cyberspace network

Another component of the concept should be an understanding of the cyberspace pragmatics - *meeting the information needs of the user: obtaining (forming) or using information depending on its purpose*.

The concept also assumes that meeting the information needs of the user requires *the presence in cyberspace of a sufficient amount of information resources (facts, information, data, information) in electronic form, i.e. EIR*.

Finally, the concept needs to clarify the important technical details identified in the above issues, which arose, in particular, regarding the concept of cyberspace defined by the legislation of Ukraine. So let's clarify these details.

Regarding the first question, we say that «virtual space» means artificially (software defined) created *local cyberspace of the user* within a more powerful computer network. For example, a global network, which is technically not virtual at all! Such virtual space is only a small part of the overall cyberspace. Therefore, to consider and define cyberspace as a virtual environment is a mistake that should not be allowed.

The second question is called into question by the contextual assertion that cyberspace covers only global computer networks. The suspicion is caused by the presence of real electronic communication processes not only in global but also in various isolated local computer networks. For example, such a topology as shown in Fig. 1, when a certain specialized information environment is created, which

is also appropriate (should) be considered cyberspace.

The third question is caused by the need to understand the boundaries of cyberspace. That is, where and how the EIR is formed, which can have a pragmatic value for the user of the computer network that provides the formation of cyberspace. In this regard, we pay attention to the topology of the computer network, shown in Fig. 1.

Let's ask ourselves a simple question: can such a network be suitable for the needs of the user without the availability of thematic information or data in digital form on at least one computer? The answer is obvious: no, it can't – such a network without thematic information content is just a «metal» structure that has the volume, weight and technical ability of computers to interact.

Let's ask another question: how can information or data in digital form *initially* appear (appear) in such a network? That is, EIR, as a substance of future network exchange (traffic) and internal information transformations in each of the computers. The answer is also obvious: initially, information or data in digital form on a computer network can appear (arise) only by external input through available gateways (interfaces). This process is implemented by a human operator or with the help of sensors (sensors) of signals or messages about the objects of the surrounding world (including remotely from the network), as shown in Fig. 2.

The diagram in Fig. 2 shows that *the boundaries of cyberspace form not only a set of computers connected by telecommunications, but also all types of sensors and sensors that have a regulated contact with network computers*. It is the sensors and sensors that provide a *sufficient amount of EIR (facts, information, data, information) in cyberspace*, both through initial creation and replenishment, as well as various transformation and use of EIR in a real or virtual computer network.

Along with the obvious example of global cyberspace, which is based on the Internet, examples of local cyberspace should be considered any specialized computerized networks that are separate from the Internet. These should be considered radar or sonar networks for environmental monitoring, navigation systems, process control systems in various industries, and so on. At the same time, according to the scale of topology branching, such networks can also be classified as global. We emphasize that, if necessary, local cyberspace can be locked with the global network, in particular with the Internet, becoming part of global cyberspace.

The doubt in fourth question is that cyberspace involves only communication (reciprocal communication). That is, two-way exchange of signals or messages is provided. But in cyberspace, processes can be carried out that do not involve such an exchange, but are performed unilaterally. Examples of such unilateral interference could be a cyberattack on a cyberspace computer network or interference with communications or electronic intelligence. That is, we are talking about the elements of the system that forms cyberspace.

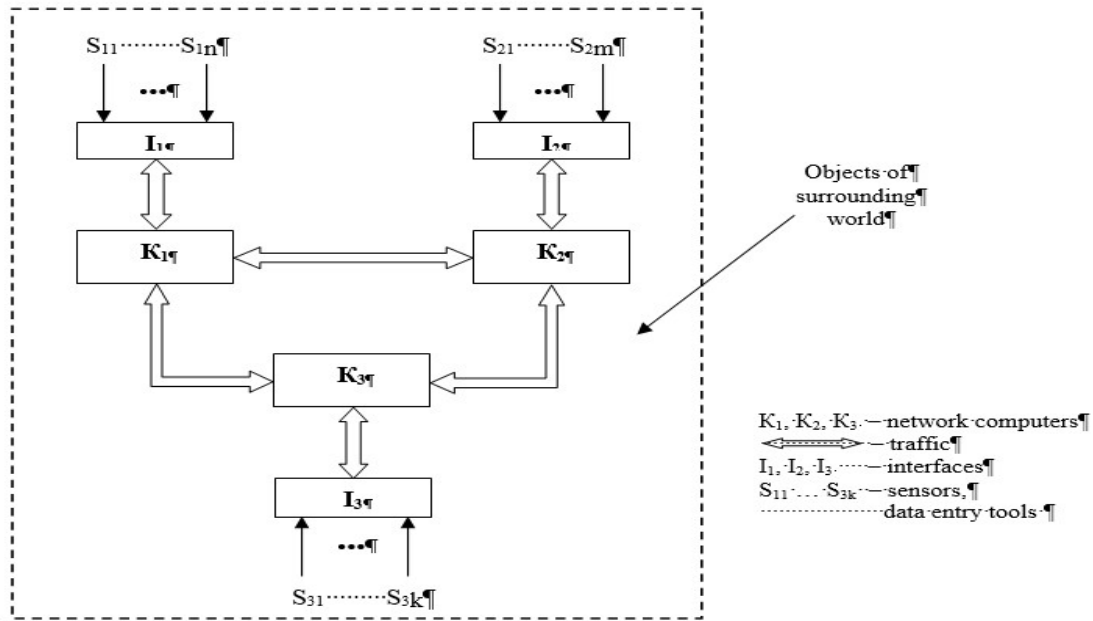


Figure 2 – Computer network with open gateways: (example of organizing the structure of local cyberspace)

As can be seen from the above, the definition of the essence of cyberspace is influenced by a range of features, the disregard of which from the standpoint of a systems approach is questionable as known formulations of this concept.

To overcome this doubt, when defining the essence of cyberspace, it is necessary to take into account only the general features that are characteristic of the whole range of features of the creation and operation of cyberspace, which is based on a computer network. In our opinion, these are the following common features:

availability of a computer network (*local or global scale*);

availability of pragmatic quality in the computer network of EIR, which are initially entered into the network;

the need to use EIR to meet the information needs of the user (consumer).

These general features allow you to get a short but systematically balanced definition:

*cyberspace – a computerized environment for the formation, storage and use of electronic information resources, which is designed to meet the information needs of the user (consumer).*

This definition does not contradict the generally accepted concept of W. Gibson-Okinawa Charter, but is generalized, which ensures its universality and application in the broadest sense.

In this case, we should also distinguish the following entities:

*local cyberspace* – a computerized EIR environment, which is formed in a separate network topology outside the global computer network;

*global cyberspace* – a computerized EIR environment, which is created within and using the resources of the global computer network;

*virtual cyberspace* is a computerized EIR environment that is created artificially (using a software) in the interests of an individual user (consumer) within a computer network of local or global cyberspace.

This definition of cyberspace and its varieties has certain accents. First, its core is the available amount of EIR, which is the target for external attacks (cyber-aggression) and at the same time the object of comprehensive protection (cyber defense). Secondly, any practitioner can consider the computerized information system created by him (connected to the global network or outside it) as his own cyberspace.

Thus, we have a systematically balanced definition of the concept of «cyberspace», which does not contradict the concept of W. Gibson-Okinawa Charter. Then it is necessary to note the difference and relationship between the essence of this concept and the essence of the «cybernetic space» concept according to N. Wiener.

Let start with the difference between these concepts. It is known that according to N. Wiener's concept, the term «cybernetic space» literally means «control space» or «control system space». In such a space, EIR is created and used to implement a specific control process. And the concept of «cyberspace» involves the use of EIR to meet any information needs of the user (consumer). Moreover, it is not necessary to implement the full cycle of the management process, but as an auxiliary option. In particular, cyberspace, especially globalized, is often used as a source of reference data. Therefore, the concepts of «cyberspace» and «cybernetic space» are not identical, so they should be separated from each other. As a result, it is illogical to identify (contextually identify) such terms as «cyberattack» and «cybernetic attack», «cyberoperation» and «cybernetic operation», etc., because they have different meanings.

Now about the relationship between these concepts. It is known that any cybernetic system (control system) is usually an information system. A stable management system operates on the principle of feedback. It consists of a control body (setting element), an executive body (effector, regulator), a control object (anything) and a sensor for monitoring the state of the control object (receptor – feedback element) [12; 13]. These elements interact as shown in Fig. 3.

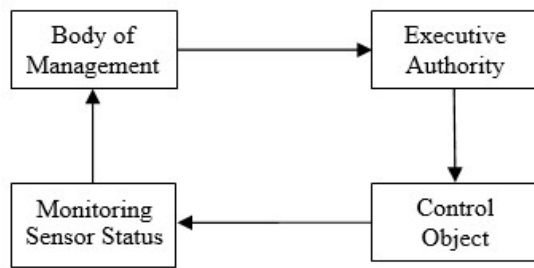


Figure 3 – Interaction of elements in a cybernetic system

When these elements of the control system are organized and operate within cyberspace, then cybernetic space is part of cyberspace (for example, this principle is carried out by cyberattacks on certain objects integrated into cyberspace, which become the object of external control). There are situations when the elements of the control system in different versions may be outside cyberspace. A conditional example of a variant of the structure of such a control system is shown in Fig. 4.

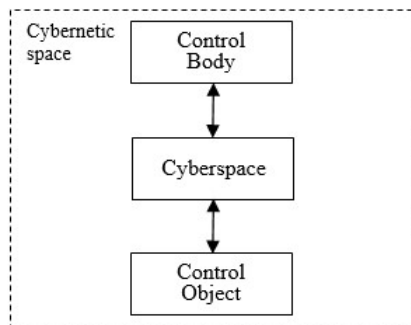


Figure 4 – A variant of the control system within the cybernetic space

In this case, we have the opposite situation - cyberspace is a component of cybernetic space (for example, this principle is the process of controlling weapons in the military or ATM in the banking system).

Thus, having an informational nature, cyberspace and cybernetic space can interact closely only within the implementation of a certain management process in accordance with the chosen way of achieving the goal of the governing body.

### Conclusions and perspectives for further research

Based on the Gibson concept, a new system-balanced (generalized) definition of the cyberspace concept is proposed, which takes into account the general features that characterize the whole range of features associated with the formation, preservation and use of EIR.

The need to distinguish between the concepts of «local cyberspace», «global cyberspace» and «virtual cyberspace» is shown.

The essence of the concept of «cybernetic space» according to N. Wiener and the essence of the concept of «cyberspace» are analyzed. It is shown that these are different concepts that should not be identified, as well as their derived terms and their concepts.

The relationship between cyberspace and cybernetic space can be manifested only within the implementation of a certain management process using the capabilities of cyberspace to achieve the goal of the governing body.

These results should be considered as a necessity to distance the cybernetic theory of N. Wiener from the latest theories related to the cyberspace concept. In addition, it is advisable to pay attention to the need to determine correctly the terminological basis of these modern theories as a basis for understanding them, which has not yet been achieved for today.

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### СУТНІСТЬ КІБЕРПРОСТОРУ ТА ЙОГО ВЗАЄМОЗВ'ЯЗОК ІЗ КІБЕРНЕТИЧНИМ ПРОСТОРОМ

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**Постановка проблеми в загальному вигляді.** Предметом дослідження є питання взаємозв'язку та різниці понять кіберпростору і кібернетичного простору. Мета статті – уточнення поняття кіберпростору та окреслення взаємозв'язку кіберпростору і кібернетичного простору. Дискусійність стосовно поняття кіберпростору і його взаємозв'язку з сутністю кібернетичного простору викликає потребу подальшого, глибшого і, водночас, узагальненого роз'яснення. Завдання полягає в розмежуванні понять кіберпростору та кібернетичного простору, а також визначення їх взаємозв'язку, оскільки ці поняття не є ідентичними за сутністю, на що часто не звертається уваги.

**Методи дослідження** Під час написання статті застосовано: системний і логічний підходи, методи порівняння та аналізу. Зазначений методичний підхід дав змогу системно проаналізувати основні поняття із префіксом «кібер», виявити розбіжності та взаємозв'язок між ними.

**Аналіз останніх досліджень і публікацій.** Невизначеність поняття терміну «кіберпростір» у розглянутих джерелах призводить до його вільного та, іноді, недоречно використання. В свою чергу, визначення термінів з префіксом «кібер» також потребує однозначності.

**Виклад основного матеріалу.** В ході аналізу відомих публікацій виявлено ряд взаємних розбіжностей тлумачення поняття кіберпростору, а також факти невиправданого ототожнення термінів «кіберпростір» та «кібернетичний простір». Незважаючи на спроби деталізації поняття кіберпростору, усі варіанти тяжіють до гібсонівського поняття «cyberspace», оскільки в основу визначення авторами покладається наявність комп'ютерної мережі та можливість інформаційної взаємодії у такій мережі. Це підтверджується і національним законодавством України. Така ситуація шкодить застосуванню єдиних підходів до розгляду цифрованих інформаційних систем та систем управління загалом, що потребує корекції.

**Елементи наукової новизни.** На основі концепції Вільяма Гібсона, яка підтримана Окінавською хартією глобального інформаційного суспільства 2000 року, а також з урахуванням загальних ознак, що характерні для усього спектру особливостей, пов'язаних із формуванням, збереженням та використанням електронних інформаційних ресурсів, запропоновано узагальнене визначення поняття кіберпростору. Враховуючи сутність поняття «кібернетичний простір» за концепцією Норберта Вінера, показано відмінність та взаємозв'язок між кіберпростором і кібернетичним простором. Визначено поняття «локальний кіберпростір», «глобальний кіберпростір», «віртуальний кіберпростір» та вказано на необхідність розрізняти їх між собою.

**Теоретичне та практичне значення статті.** Отримані результати підкреслюють необхідність дистанціювати класичну кібернетичну теорію від новітніх теорій, пов'язаних із поняттям кіберпростору. Цим також звертається увага на потребу коректного застосування термінологічної бази сучасних теорій як основи розуміння їх положень, в інтересах розвитку та належного функціонування цифрових інформаційних систем та систем управління.

**Висновок і перспективи подальших досліджень.** Терміни «кіберпростір» та «кібернетичний простір» є різними за сутністю, тому їх еквівалентне використання в теорії та практиці недоступиме. Подальші дослідження доцільно зосередити на реалізації підходу щодо правильного використання зазначених термінів, зокрема, під час розгляду питань кібербезпеки та процесів управління.

**Ключові слова:** кіберпростір, кібернетичний простір, взаємозв'язок.

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